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The Deterioration of Felled Western Yellow Pine on Insect Control Projects.[1]

by

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Introduction.

During the past fifteen years extensive insect control measures have become necessary in various localities in the western United States in order to check epidemics of the western pine beetle (Dendroctonus brevicomis Lec.) and the mountain pine beetle (Dendroctonus monticolae Hopk.) on western yellow pine (Pinus ponderosa Laws.), lodgepole pine (Pinus contorta Loud.), western white pine (Pinus monticola Dougl.) and sugar pine (Pinus lambertiana Dougl.). Briefly, control consists in felling, barking and usually burning the bark of infested trees in order to destroy the overwintering stages of the beetles.

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[1]This study was made at the request of Mr. J. F. Kimball, Secretary-Treasurer of the Klamath Lake Counties Forest Fire Association at Klamath Falls, Oregon. Without the yearly records of the Association giving the location of felled trees the study would have been impossible. The writer is also indebted to Mr. H. H. Ogle of the same Association for valuable assistance in securing the field data.

The attacks of the western pine beetle on western yellow pine have been very widespread and consequently the most extensive control projects have been concentrated on this tree species. At present control work is under way in the yellow pine regions of British Columbia and central California, while a large project will be begun in the spring of 1922 in the Klamath Lake region of southern Oregon.

The Klamath Lake project in the spring of 1922 alone necessitates the felling of about 16,000 merchantable western yellow pines with an occasional sugar pine comprising approximately 16,000,000 feet board measure over an area of roughly 200,000 acres. Further work in the next three or four years will probably involve cutting an additional 20,000,000 feet board measure of merchantable timber on adjoining areas. These trees must be left on the ground until such time as they can be reached by logging operations. The rate of deterioration of this felled timber then becomes of paramount importance. It is in connection with this project that the study reported here was made.

Method of Collecting Data

Local control work has been carried on in this region for some years by the Klamath Lake Counties Forest Fire Association and records of this Association were available giving the general location of trees felled yearly since 1915. From these records, felled trees were re-located and examined during November 1921.

Each tree was opened up sufficiently with axe and saw to permit scaling in sixteen foot logs with the Scribner Decimal C scale according to standard commercial practice. Logs two-thirds or more unmerchantable by volume were culled. Diameter measurements were taken to the nearest inch and length measurements to the nearest tenth of a foot. The gross scale where given is the actual merchantable volume in the trees at the time of felling. In making the measurements of decay the subsequent advance of any decay in the living tree at the time of felling was disregarded. The only two decays found in the trees examined which had been there at the time of felling, that is, red rot caused by the ring scale fungus (Trametes pini (Thore) Fr.) and red brown butt rot caused by the velvet top fungus (Polyporus schweinitzii Fr.) apparently advanced little, if at all, in the down trees.

Data were secured on a total of one hundred trees, all western yellow pine, near Bly, Klamath Falls, and Keno, in Klamath County, Oregon, at elevations around 6,000 feet above sea level. These trees varied from 16 inches to 43 inches in diameter inside bark at stump height and the usual stump height ranged from 2½ to 3 feet.

Rate of Deterioration.

These felled trees deteriorate with extreme rapidity--far more rapidly than the casual observer is lead to believe. The heat from burning the bark and from the sun's rays results in a pronounced drying of the outer sapwood to

a depth of about one-half inch more or less. This outer layer, being too dry to decay, remains hard and sound for several years, and if tested superficially leads to the belief that the tree is sound throughout, when as a matter of fact it may be a complete loss through incipient decay.

Table I shows the rate of deterioration.

Table I--Rate of deterioration of felled western yellow pines.

When Cut	Seasons of exposure	Volume in Board Feet: Gross	Cull	Net	% Cull	Trees with Merchantable Volume: No.	% of Total	Average D.i.b. Stump Inches	Number of Trees Basis
A 1921:	1	6,400:	810:	5,590:	13	6:	100	24	6
D 1920:	1	11,350:	2,060:	9,290:	18	12:	100	23	12
F 1920:	2	11,610:	7,360:	4,250:	63	11:	79	23	14
N 1919:	2	8,080:	6,120:	1,960:	76	6:	75	21	8
S 1919:	3	15,870:	12,900:	2,970:	81	10:	62	24	16
S 1918:	4	2,650:	1,790:	860:	68	3:	100	23	3
A 1917:	5	35,510:	28,960:	6,550:	82	7:	44	31	16
S 1916:	6	13,270:	12,060:	1,210:	91	2:	14	23	14
S 1915:	7	11,470:	10,710:	760:	93	1:	9	25	11

A--April, D--December, F--February, N--November, S--Spring.

In the above table "seasons of exposure" means the number of growing seasons that have elapsed since the trees were felled. It is of course, during the growing season that the greatest deterioration occurs, although loss does continue throughout the year. This is shown by the trees cut in April 1921 and exposed for one season having a loss of 13 per cent while those cut in December 1920, also exposed for one season but with four additional months in winter and early spring, have a loss of 18 per cent. The same relation holds for the trees exposed for two seasons but cut at different times.

The important feature of table I is the enormous increase in the cull per cent after the first season. This increase of from 13 and 18 per cent to 63 and 76 per cent is so great, that from an economic standpoint felled trees must be utilized before they pass into the second season of exposure. This means that the bulk of trees cut on a control project must be regarded as a loss since it is at present commercially impossible to so adjust logging operations that scattered trees over a large area can be picked up in a single season.

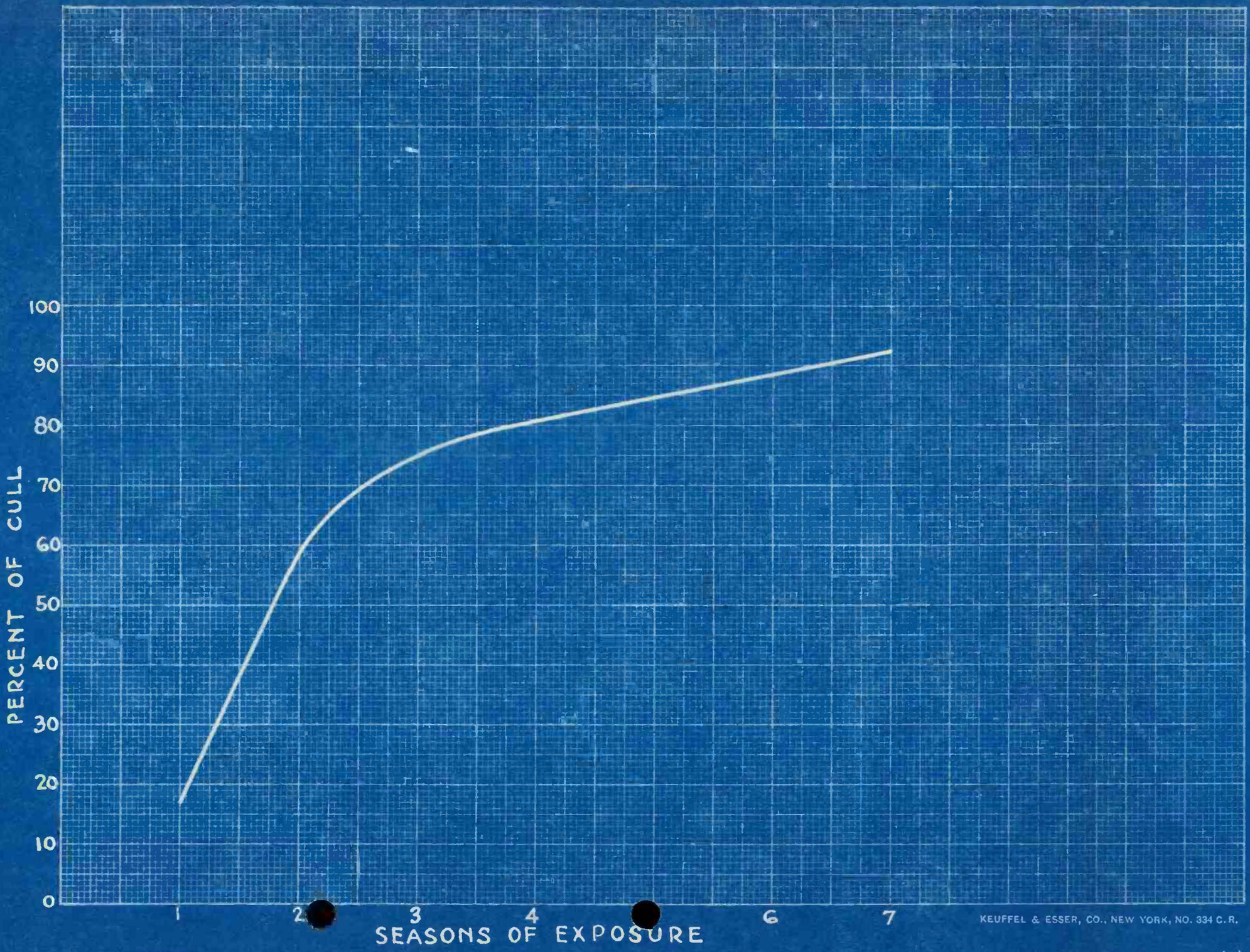
From the second season on deterioration increases steadily until by the end of the seventh season there is little merchantable volume to be obtained, and this only in an occasional tree much larger than the average, or with some

other abnormal condition. For example the merchantable volume in the trees cut in 1916 came from two trees only. One of these was a large tree with a diameter inside bark at stump height of 37 inches, while the other, though 11 inches smaller in the same measurement had an unusually resinous butt log. The 760 feet board measure in the 1915 trees came from the first three logs in a 43 inch tree.

The criticism may be made that table I is based on insufficient data. An examination of the table will show that the trees are well distributed by seasons of exposure, except in the case of those cut in 1918, of which there are only three--all that could be obtained. The basis for this class is insufficient. The cull per cent shows a steady increase and the per cent of total trees with merchantable volume a steady decrease except in the 1918 trees. This points to a sufficient basis for the other classes. Then too, during the course of the field work the similarity in condition between trees exposed for the same number of seasons was so apparent that it was not considered necessary or advisable to further prolong the field work in order to collected data on more trees.

Figure 1, which is derived from table I, illustrates graphically the rate of deterioration of the down timber.

FIGURE 1



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Causes of Deterioration

In table I sap stain is not considered a defect. While this discoloration does degrade the lumber, discolored wood can still be used for a variety of purposes. In this region blue stain caused by the fungus Ceratostomella sp. is most common, while a brown stain, of which the causal fungus is unknown, is sometimes found. Staining is practically confined to the sapwood, rarely penetrating the heartwood. It is rather easy to misjudge the amount of stain in a tree. As previously pointed out there is a very dry outside layer of sapwood, too dry to stain, and a hasty examination may indicate that the wood is bright, but deeper chopping will reveal the stain. By the end of the first season all the sapwood, with the exception of the outer layer was heavily stained in the trees examined. In the upper portions of the trees where the bark had been left on this outer layer, since it had been kept moist, was also stained. The discoloration first began along the checks and then spread over the entire sapwood. Considering stained sapwood as a defect in table I the loss after one season of exposure would amount to 78% in the trees cut in April 1921 and 67% in the trees felled in December 1920. This difference may be mere chance or it may indicate that the winter felled trees due to longer exposure were somewhat drier and consequently less susceptible to discoloration by the time favorable climatic conditions

for staining occurred in the late spring and summer. Observations made on wind-thrown yellow pine in this region showed that heavy staining began in July. To avoid sap stain as much as possible, trees should be logged before that time.

That the principal causes of deterioration were relatively few and well defined is shown by the following table.

Table II--Causes of deterioration of felled yellow pines.

When Cut	Seasons of Exposure	Cull--Per cent of Gross Volume					
		Checks	Sap Rot	Heart Rot	Broken in Felling	Burned	Borers
A 1921:	1	13.7	--	--	--	--	--
D 1920:	1	16.2	1.5	--	0.2	0.3	--
F 1920:	2	16.9	24.6	--	--	21.9	--
N 1919:	2	11.5	57.3	--	3.7	3.2	--
S 1919:	3	--	59.4	9.8	1.2	11.1	--
S 1918:	4	--	63.4	4.2	--	--	--
A 1917:	5	1.4	53.2	15.0	0.5	9.6	1.9
S 1916:	6	3.9	63.7	14.1	0.8	8.3	--
S 1915:	7	0.3	57.0	30.3	--	5.8	--

The most important cause of cull in the trees exposed for one season was checks. Checks were mostly confined to the sapwood but in some cases extended deep into the heartwood. Checking usually began and was most severe on the side of the trunk exposed to the direct rays of the sun, although exceptions to this rule were found where particularly intense heat when

the bark was burned had caused severe checking. Normally the loss through checking in any one tree resulted from several or numerous checks, but in a very spiral grained tree, a single deep check twisting around the tree sometimes caused all the loss.

There was little sap rot during the first season. In fact the entire 170 board feet given in table II occurred in a single tree. But by the end of the second season the loss from this cause was heavy and continued so. In fact from then on sap rot was the most important factor in deterioration. In small or medium sized trees with wide sapwood, sap rot by amounting to two-thirds or more of the gross volume often caused the loss of the entire tree. It followed then that small or medium sized trees were subject to much more rapid deterioration than large trees.

The upper side of the trunk decayed most rapidly and the under side, the portion resting on the ground, much more slowly. This is probably explained by the retarding effect on the development of wood destroying fungi of the much higher moisture content, lessened oxygen supply and lower temperature of the wood of the under side as compared to the upper side. Decay first appeared along the checks but avoided the dried out outer layer of sapwood. Tongues of decay extended down from the ends of the checks. The decay then spread out from the checks, finally involving the entire sapwood with the exception of the outer layer. Where the bark was left on in the top,

the outer layer also decayed. Barking the tree somewhat retards decay, but not enough to be of practical importance, while on the other hand it promotes checking.

Generally it was impossible to determine the exact kind of decay in the different trees, but where this was done it was found that western red rot caused by Polyporus ellisianus Murr. was most common, while a brown friable rot caused by the brown Lenzites (Lenzites sepiaria (Wulf.) Fr.) and a yellow brown friable rot caused by the red belt fungus (Fomes pinicola (Fr.) Cke.) occasionally occurred.

Heart rot was not found in the trees until the third season of exposure. Decay first appeared as tongues running in from the sapwood, or following in along deep checks. Western red rot was most common.

A negligible amount of loss resulted from breaks, usually in the top, when the trees were felled.

A more important source of cull was fire. This sometimes did considerable damage. When the bark was burned, trees with open wounds were very likely to burn out along the scar and for some distance in advance. Fire scars in pitchy butts in particular were common starting points for destructive burns. Felling trees across one another or leaving limbs resting on the trunk resulted in additional loss from fire.

The loss caused by wood boring insects was negligible. Ambrosia beetles did not attack the trunk from which the bark

had been removed, while the round-head and flat-head borers did not attack the trees until sap rot was well started.

From the foregoing discussion of table II it is apparent that while checks caused some loss and in a lesser degree so did fire, that decay, particularly the very rapid decay of the sapwood is responsible for most of the deterioration in these trees.

Conclusion

The facts brought out in this paper should not be considered as of value for local application only. The climatic conditions of the Klamath Lake region characterized by a small yearly precipitation, with a long summer drouth often beginning in the late spring and extending well into the fall, and low winter temperatures are exactly similar to most of the yellow pine belt of eastern California, Oregon and Washington and not markedly at variance with conditions in other western yellow pine regions in North America.

These results should prove generally applicable on control projects in western yellow pine with minor variations. Timber averaging smaller than that studied here will deteriorate more rapidly, while the deterioration in larger timber will of course be slower.

The felled and barked trees were completely sap stained by the end of the first season of exposure. If sap stain is considered a serious enough defect to make discolored

wood worthless for lumber, there is such a large loss the first season, that utilization is imperative by midsummer. However, as a rule, stained lumber is only degraded and not culled.

Deterioration is very rapid and is chiefly caused by decay, particularly the very rapid decay of the sapwood, followed more slowly by the breaking down of the heartwood. The resulting loss is so high by the end of the second season, that felled trees must be utilized by the beginning of this time, or else the volume of merchantable wood obtained is so small as to be of little commercial importance. Consequently the timber in most of the trees cut on a control project becomes a complete loss, since under present economic conditions it is usually not possible to utilize scattered trees over a large area in such limited time.

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